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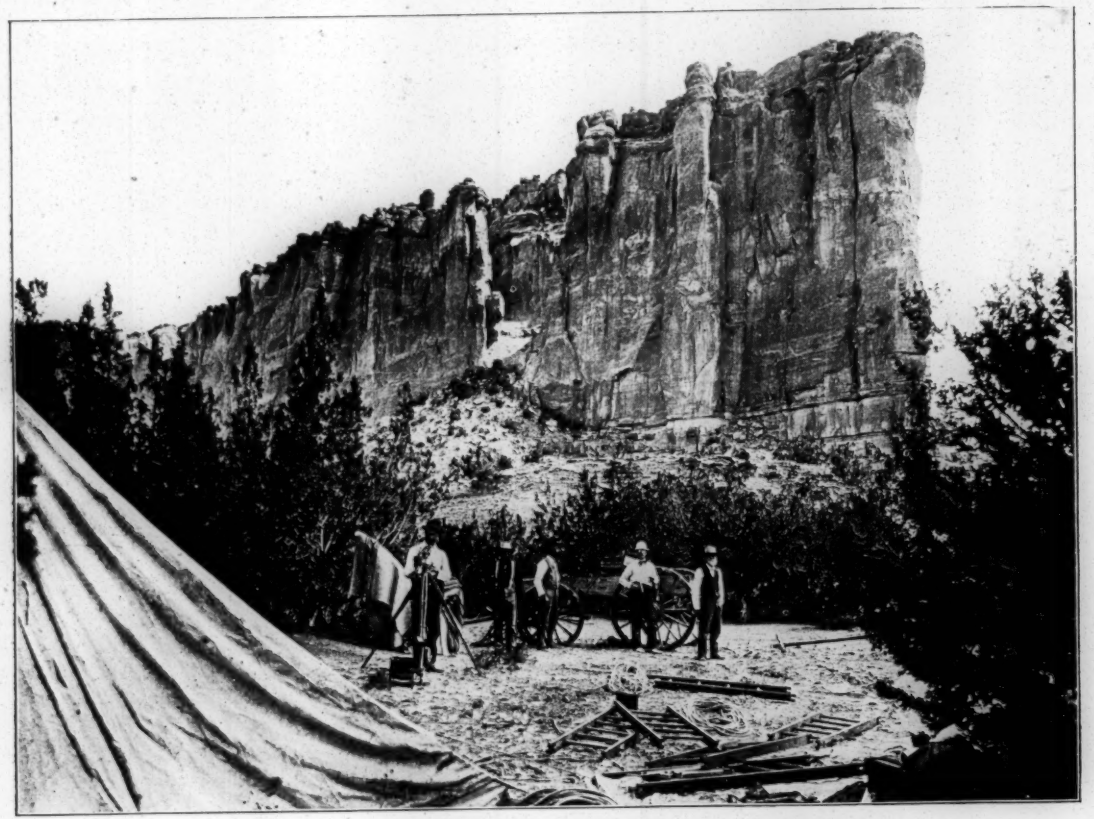

THE ENCHANTED MESA — THE GREAT SOUTHWESTERN CLEFT AND TALUS HEAP

THE

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THE ENCHANTED MESA

By F. W. HODGE,

Bureau of American Ethnology

The pueblo of Acoma, in western central New Mexico, is the oldest settlement within the limits of our domain. Many of the walls that still stand on that beetling peñol were seen by Coronado during his marvelous journey in 1540, and even then they were centuries old.

The valley of Acoma has been described as "the Garden of the Gods multiplied by ten, and with ten equal but other wonders thrown in; plus a human interest, an archeological value, an atmosphere of romance and mystery;" and the comparison has not been overdrawn. Stretching away for miles lies a beautiful level plain clothed in grama and bound on every side by mesas of variegated sandstone rising precipitously from 300 to 400 feet, and relieved by minarets and pinnacles and domes and many other features of nature's architecture. About their bases miniature forests of piñon and cedar are found, pruned of their dead limbs by native wood-gatherers. Northwestward, Mount Taylor, the loftiest peak in New Mexico, rears its verdant head, and 20 miles away to the westward the great frowning pine-fringed Mesa Prieta, with the beautiful vale of Cebollita at its feet, forms a fitting foreground to every dying sun.

But none of these great rock-tables is so precipitous, so awe-inspiring, and seemingly so out of place as the majestic isolated Katzímo or Enchanted Mesa, which rises 430 feet from the middle of the plain as if too proud to keep company with its fellows; and this was one of the many wonderful homesites of the

Acomas during their wanderings from the mystic Shípäpu in the far north to their present lofty dwelling place.

Native tradition, as distinguished from myth, when uninfluenced by Caucasian contact, may usually be relied on even to the extent of disproving or verifying that which purports to be historical testimony. The Acoma Indians have handed down from shaman to novitiate, from father to son, in true prescriptorial fashion for many generations, the story that Katzímo was once the home of their ancestors, but during a great convulsion of nature, at a time when most of the inhabitants were at work in their fields below, an immense rocky mass became freed from the friable wall of the cliff, destroying the only trail to the summit and leaving a few old women to perish on the inaccessible height. What more, then, could be necessary to enwrap the place forever after in the mystery of enchantment?

This tradition was recorded in its native purity some twelve years ago by Mr Charles F. Lummis, who has done so much to stimulate popular interest in this most interesting corner of our country, and the same story was repeated by Acoma lips to the present writer while conducting a reconnaissance of the pueblos in the autumn of 1895. During this visit, desiring to test the verity of the tradition, a trip was made to the base of Katzímo, where a careful examination of the talus (especially where it is piled high about the foot of the great southwestern cleft (Pl. 32, 33) up which the ancient pathway was reputed to have wound its course) was rewarded by the finding of numerous fragments of pottery of very ancient type, some of which were decorated in a vitreous glaze, an art now lost to Pueblo potters. The talus at this point rises to a height of 224 feet above the plain, and therefore slightly more than half-way up the mesa side. It is composed largely of earth, which could have been deposited there in no other way whatsoever than by washing from the summit during periods of storm through many centuries. An examination of the trail to a point within 60 feet of the top exhibited traces of what were evidently the hand and foot holes that had once aided in the ascent of the ancient trail, as at Acoma today. Even then the indications of the former occupancy of the Enchanted Mesa were regarded as sufficient and that another one of many native traditions had been verified by archeologic proof.

Enchanted Mesa has become celebrated during the last summer through the reports of the expedition of Prof. William Libbey, of Princeton, who, after several days of effort, succeeded in scal-

THE GREAT SANDSTONE CLEFT OF THE MESA

Through this cleft the traditional trail passed, and distinct traces of it are to be seen on each side of the vertical fissure to the right of the upper ladder

ing the height, in the latter part of July, by means of a life-saving equipment. It would seem that Professor Libbey neglected to search for relics in the talus, that he devoted no attention to the great southwestern cleft or cove up which the trail was reputed to have passed, and that after spending some three hours on the narrow southern extension of the mesa top, awaiting the arrival of a ladder from Acoma to conduct him across a fissure, he employed the remaining two hours in a reconnaissance of the wider and more interesting part of the height, finding nothing that would indicate even a former visit by human beings.*

While engaged in archeologic work in Arizona and later in Cebollita valley in western central New Mexico, some 20 miles westward from Acoma pueblo, I was directed to visit Katzímo once more in order to determine what additional data of an archeological nature might be gathered by an examination of the summit. The knowledge gained by the previous visit made it apparent that a light equipment only would be necessary to accomplish the task. Procuring an extension ladder, comprising six 6-foot sections, some 300 feet of half-inch rope, and a pole-pick, together with a number of bolts, drills, etc., which afterward were found to be needless, I proceeded to Laguna, the newest, yet the most rapidly decaying, of all the pueblos, on the Santa Fé Pacific railroad. Here I was fortunate in enlisting the services of Major George H. Pradt, who has served as a United States deputy surveyor in that section for nearly 30 years; Mr A. C. Vroman, of Pasadena, California, a few of whose excellent photographs are here reproduced, and Mr H. C. Hayt, of Chicago. Much of the success of the little expedition is due to the untiring aid of these gentlemen, and for many creature comforts I am indebted to the Messrs Marmon, whose beautiful little home at Laguna has delighted the heart of many a weary wayfarer in that sunny land.

Leaving the railroad September 1, we proceeded with two farm wagons, each drawn by a very small black mule and a large white horse, driven by two sturdy Laguna boys. The road trends westward for about seven miles, then turns southward through a rather wide valley scarred with arroyas and lined with

* Had the explorer crossed to the northern part of the mesa by means of a bench a few feet below the summit of the rocky southern tongue, it would not have been necessary for him to spend most of his time so fruitlessly in awaiting the arrival of means to cross the fissure. The ladder was found as Professor Libbey had left it, but was taken down by one of the Indians, who followed the bench mentioned, in order to secure the rope for his own use. The ladder is the short one shown in Pl. 33, the photograph having been made during the descent.

fantastically carved sandstone cliffs. The summit of Mesa Encantada is visible for several miles ere the vale of Acoma is reached, and as one enters the valley proper he cannot fail to appreciate the wisdom displayed by the natives in the selection of the beautiful, grassy, mesa-dotted plain that has been their home for so many generations.

The next day was spent in the village witnessing that curious anomaly of paganism intermixed with christianity, known as the Fiesta de San Estevan. On the morning of the 3d an early start was made for Mesa Encantada, which lies three miles northeastward from the pueblo, just within the eastern boundary of the Acoma grant, in latitude 34° 54′ N., longitude 107° 34′ W.

The remainder of the forenoon was employed in making camp in the little grove of cedars at the base of the cleft near the southwestern corner of the height, in unpacking apparatus, and in determining the altitude of the mesa above the western plain. The observations of Major Pradt show that the elevation of the foot of the great talus slope above the plain is at this point 33 feet, the apex of the talus 224 feet above the plain, and the top of the highest pinnacle on the summit of the mesa overlooking the cleft 431 feet * above the same datum. (Pl. 32.)

The start from camp was made at noon. The ascent of the talus, in which the potsherds had been observed in such considerable quantities two years previously, was made in a few minutes, the ladders, ropes, and photographic and surveying instruments being carried with some effort, since climbing, heavily laden, at an altitude of 6,000 feet, in a broiling sun, is no trifling labor; but the real work began when the beginning of the rocky slope of the cleft was reached. One member of the party, taking the lead, dragged the end of a rope to a convenient landing place, where a dwarf piñon finds sufficient nourishment from the storm-water and sand from above to eke out a precarious existence. Fastening the rope to the tree, the outfit was hauled up, and the other members of the party found a ready means of ascent. The next landing was several feet above, at the base of a rather steep pitch of about twelve feet. This wall, although somewhat difficult to scale, may be climbed with greater or less safety by the aid of several small holes in its face. These holes were doubtless made artificially, but as the narrow pathway at this point is now a drain-

*These elevations were determined trigonometrically by means of an engineers' transit, using a base-line of 660 feet measured opposite the cleft, the observations from the northern end of the line giving 430 feet and from the southern end 432 feet; mean, 431 feet.

age course during periods of storm, the soft sandstone has become so much eroded that they have apparently lost their former shape. The cliff at this point was readily surmounted with the aid of two sections of the ladder, a rope being carried over the slope above and secured to a large bowlder in the corner of a convenient terrace some 60 feet below the summit.

This was the point which I reached during the 1895 visit. At that time I spent several minutes on this ledge, making diligent

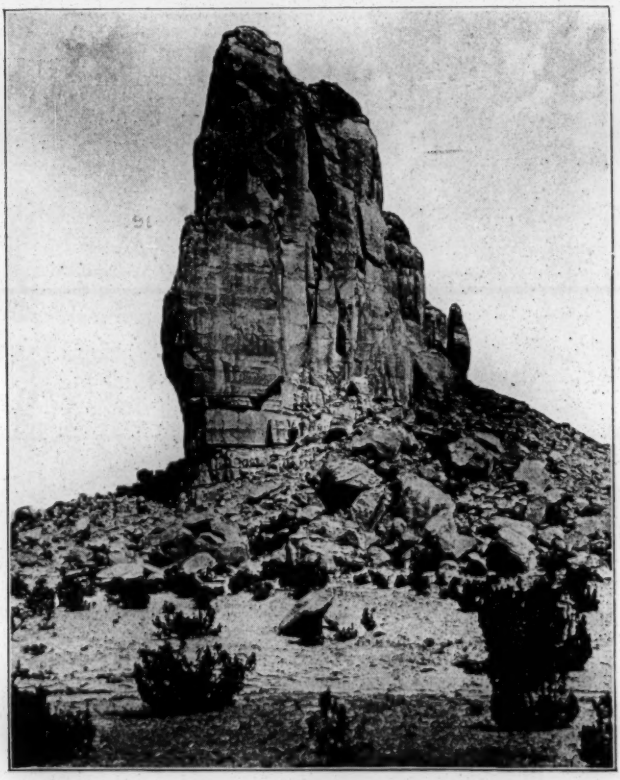
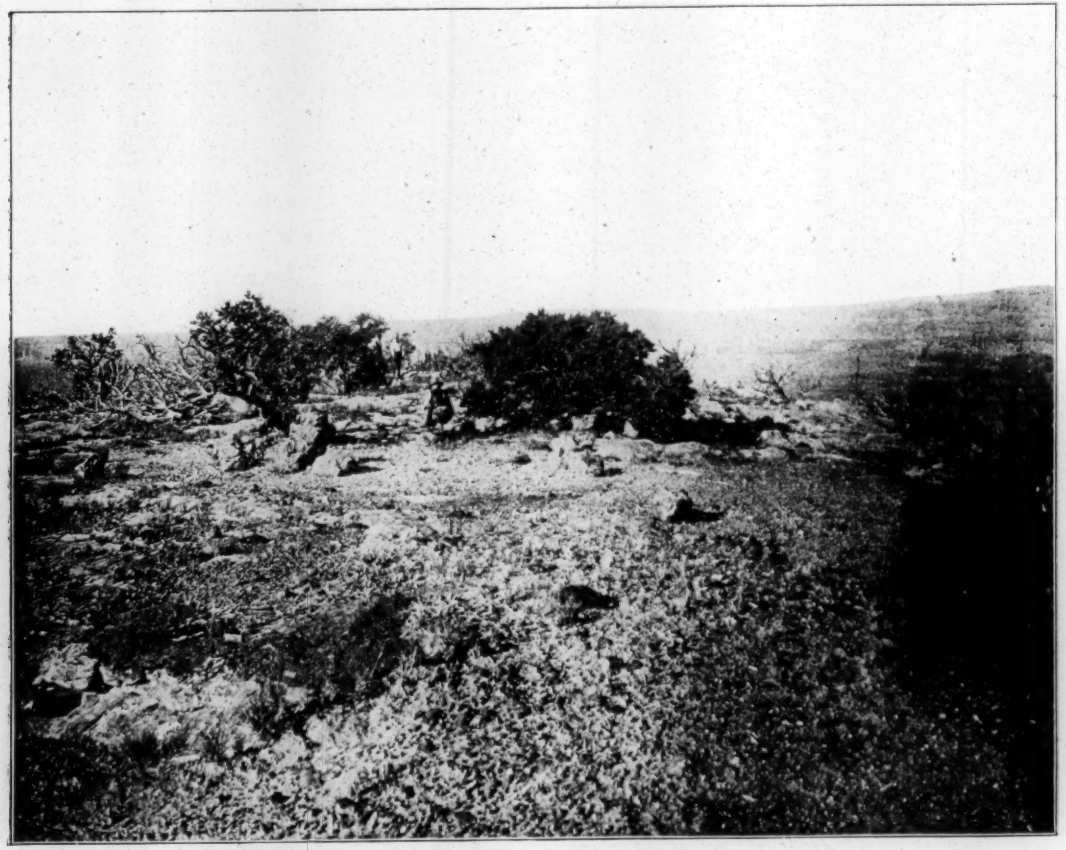


FIG. 1—ENCHANTED MESA FROM THE SOUTH

search on the walls of the cove for evidences of pictographs, but finding none. This does not signify that none ever existed, for both here and elsewhere about the cliffs great blocks of stone have fallen away so recently that their edges have not yet had time to round by erosion, and the now exposed faces of their former abiding places on the cliff wall are yet unstained by weathering. (See Fig. 1.)

The bowlder previously alluded to rests in a corner of the terrace below a long crack that extends the entire height of the 30 feet of wall (Pl. 33), just as it had appeared to me before, and I well remember viewing the chasm while seated on it. I note these circumstances, since one of the first things that met my gaze on reaching this point during our late climb was a collection of four oak sticks, lying beside the bowlder, that I am sure were not there during my previous climb. They were about 2½ feet in length, an inch thick, and had been freshly pointed at each end with a sharp tool, evidently a hatchet. Their occurrence here suggested a careful investigation of the fissure above, which resulted in the finding of a regular series of pecked holes, apparently very ancient, for their edges had been so eroded that they are now visible only on close examination. So shallow, indeed, had the holes been worn that I at once saw that while the pointed sticks afforded an indication of the former use of the holes, it would have been impossible for the latter to have been employed as a means of scaling the wall in modern times. I therefore concluded that the sticks had recently been left there by one who desired to gain access to the summit, but had failed in the attempt. This conclusion was confirmed immediately afterward when I found, almost beneath the bowlder, a sherd of typical modern Acoma pottery and an unfeathered prayer-stick, and a few moments later Mr Hayt dug from the moist sand in the corner other fragments of the same vessel, evidently the remains of a sacrifice, which, had it been accessible, would doubtless have been deposited on the summit. It should here be said that the difference in ancient and modern Acoma ceramics is far greater than between modern Acoma and Zuñi ware, for example, and it requires no very intimate acquaintance to enable anybody to readily distinguish the one variety from the other in the latter types.

After making this interesting find we proceeded to fit together the entire ladder in order to scale the 30 feet of sheer wall now before us. Selecting the middle of the eastern face of the cove as the most convenient and least hazardous point of ascent, the ladder was adjusted and carefully raised, section by section, until it reached the lower part of the sloping terrace above. Two holes were then pecked in the soft sandstone floor to prevent the now almost vertical ladder from slipping forward down the chasm. Again a member of the party went forward, drawing with him a rope fastened about the waist, the remaining three



THE FLATTEST PART OF THE SUMMIT, LOOKING SOUTH

The slope east and west is readily discernible, and several dead cedars may be seen on the bare rock, the earth having been washed over the precipice. The film of surface soil barely covers the rocky floor

(the Indians stayed below) holding the ladder as rigidly as possible; yet it swayed and creaked and bent like a reed until the top was reached, and it required no little care to step from an upper rung to the dizzy sloping ledge without forcing the ladder from its insecure bearing. The shelf was gained in safety, however; the rope was tied to a rung and made fast around a large block of stone on the terrace to the left. The others ascended, one by one, each with the rope tied around his chest and drawn about the rock by the leader as a measure of precaution. Then the equipage, wrapped in blankets, was fastened to the end of a rope thrown to the two Indians below and drawn up, piece by piece. The remainder of the ascent was made without difficulty. The time consumed by the entire climb was somewhat over two hours.

If the view from the valley at Acoma is beautiful, that from the summit of Katzímo is sublime. Mesa Prieta was sullen still, and the pink mesas, haughty in their grandeur from the plain, now seemed to realize their insignificance in the light of the glories beyond. Placid little pools, born of the storm the day before, lay glinting like diamonds on an emerald field, while old Mount Taylor tried in vain to lift his lofty head above the clouds that festooned the northern horizon.

The summit of Encantada has been swept and carved and swept again by the winds and rains of centuries since the ancestors of the simple Acomas climbed the ladder-trail of which we found the traces. The pinnacled floor has not always appeared as it is today, for it was once thickly mantled by the sherd-strewn soil that now forms a goodly part of the great talus heaps below. The walls of the dwellings, undoubtedly of the sun-baked mud-balls that Castañeda describes, must have been erected on this soil stratum, for the native finds in earth, when he has it, a better footing for his walls than he does on bare rock, and one may readily see that the film of soil that still remains occurs in places that would have afforded the best sites for dwellings. (Pl. 34.)

The day before was a day of storm; it even rained hard enough to drive an Indian from his religion, and yet not a cupful of water found a resting place on the entire mesa surface save in a few "potholes" eroded in the sandstone. The water had poured over the brink in a hundred cataracts, each contributing of the summit's substance to the detritus round about the base as in every storm for untold ages.

There is little wonder, then, that I despaired of finding even

a single relic when we had reached the top of the trail and looked about at the destruction wrought; and yet we had been on the summit only a few minutes when Major Pradt found a sherd of pottery of very ancient type, much crackled by weathering. This fragment is of plain gray ware, quite coarse in texture, with a dégraissant of white sand.

Beginning at the eastern side we immediately began to explore the rim of the escarpment, in a short time encountering the rude monument which had been observed by Professor Libbey, who

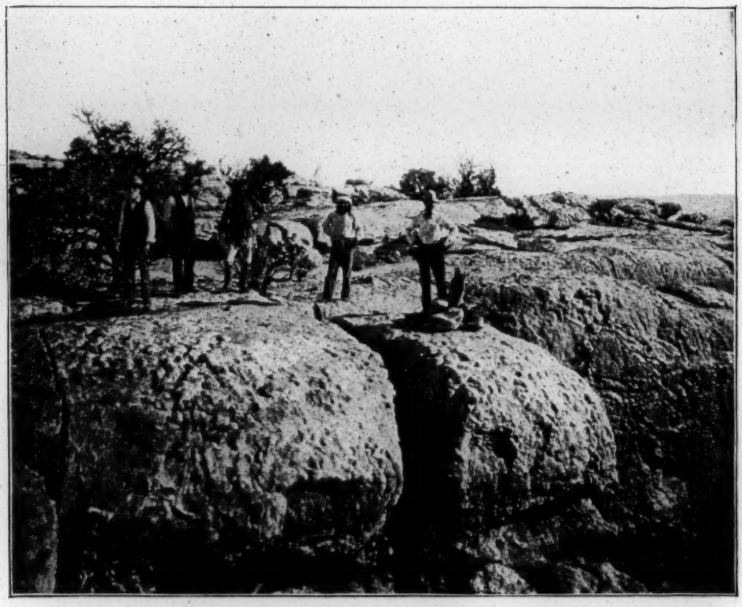


FIG. 2—AN ARTIFICIAL MONUMENT ON THE SUMMIT

expresses the opinion that it may have found its origin in erosion; but it seems to me, as I think it will appear to any one who will examine the accompanying illustration (Fig. 2), that only a glance is necessary to determine beyond all doubt that the pile could not have been erected save by the hand of man. The structure stands on a natural floor of sandstone at the edge of the eastern cliff, and consists of a narrow slab some 30 inches in length held erect by smaller slabs and bowlders about the base, the stratification of the upright slab being vertical, that of the supporting stones horizontal. It would have been impossible for the structure to have originated by any but artificial means.

The reconnaissance of the eastern rim was continued northward and of the western edge southward, but no further evidences of aboriginal occupancy were observed. The sun was lowering, so that we were compelled to suspend the investigation in order to make preparation for our night's camp. After supper, Mr Vroman and Mr Hayt built a huge fire, for the evening air at this altitude is very chilly. We passed the night in questionable comfort and were out of our blankets at dawn. After a hasty breakfast, we immediately began a survey of the mesa

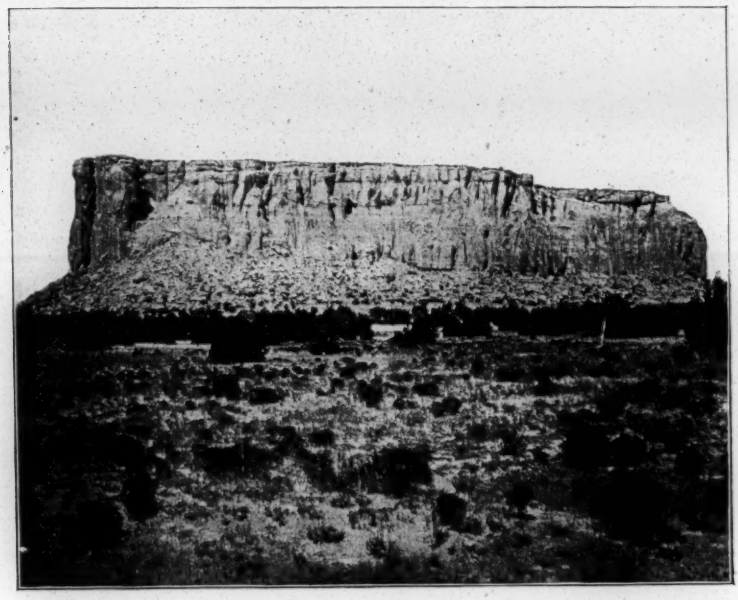


FIG. 3—THE ENCHANTED MESA FROM THE SOUTHEAST

rim, and while thus engaged were somewhat surprised to find three Acomas among us. They were scarcely friendly at first; indeed, according to the story of our two Lagunas, who had spent the night in the camp below, they had seen our fire and had come with the avowed intention of compelling us to descend, even if they had to threaten to cut down our ladder. A little explanation, however, coupled with the information that we kept our coffee and sugar in a crevice beyond the camp fire, soon appeased any wrath that may have been concealed in their bosoms and induced communicativeness.

These three natives were Luciano Cristoval, teniente of the

tribe and a medicine priest; Luis Pino and Santiago Savaró, principales. After careful inquiry in regard to the tradition of the former occupancy of Katzímo, Luciano informed us that "the elders" had lived there so long ago and the storms in his country were so destructive that we could now hardly expect to find any remains on the surface of the mesa. When we told him and his companions that a potsherd had already been found, they became deeply interested and manifested no little anxiety to find other evidences of the lofty homesite of their ancestors. I think there can be no doubt that this was the first visit of any of the present Acomas to the mesa top. They evinced much curiosity in the place, and were greatly surprised when we took them to the stone monument, of which they could give no satisfactory explanation. It is needless to say that the natives did not intimate that the pile was due to natural causes.

As already stated, the Indians were deeply interested in finding further evidence of occupancy, and I encouraged them to search for relics. They had proceeded only a few yards, accompanied by Major Pradt, when the teniente found a fragment of ancient pottery quite similar to the sherd picked up the evening before. A few moments later several more fragments were found (two of them of different kinds of indented ware), as well as a portion of a shell bracelet still bearing evidence of considerable wear, and a large arrowpoint. Soon after the keen-eyed Luciano discovered near the northern rim of the mesa the blade end of a white stone ax, on the edge of which several small notches had been made. The exposed side of this implement was thoroughly bleached and crackled, while the side in contact with the ground was stained and still damp when the finder handed it to me. After descending the mesa the same Indian exhibited the blade end of another ax which showed a portion of the groove and which was notched similarly to the other. He had found it on the summit, or rather on a ledge a few feet below the summit. Both Mr Hayt and myself tried to purchase it, but the Indian refused to part with the specimen, as he was a medicine priest and desired to keep it for ceremonial use. Like the other implement, this ax was thoroughly bleached on one side by weathering, the unexposed side being stained through contact with the lichen-covered ground.

We descended the mesa about noon of the second day (September 4), having spent about 20 hours on the summit. During this time I employed every opportunity in making a critical

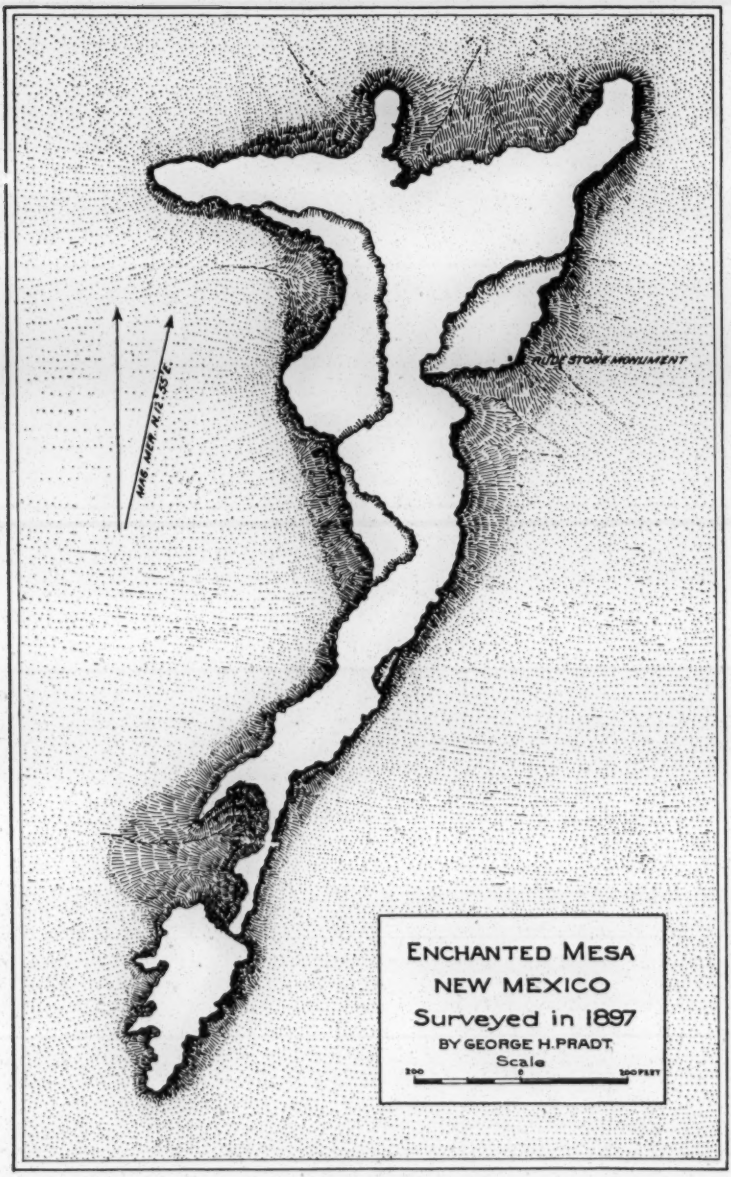


FIG. 4—MAP OF THE MESA SUMMIT

study of the general features of the top of Katzímo throughout the 2,500 feet of its length (see Fig. 4), devoting special consideration to the topography of the site, the erosion, the earthy deposits, the drainage, and the great cedars that stand gaunt and bare or lie prone and decaying because their means of subsistence have been so long washed away, and I was forced to the conclusion that had house-walls, whether of stone or adobe, ever existed on the summit at a reasonably remote period, there is no possibility that any trace of them could have remained to this day. The abundance of ancient relics in the talus, the distinct remains of the ladder-trail, the specimens found on the summit coupled with the destruction wrought by nature, the tradition itself—all testify to the former habitation of the site.

To the Acomas Katzímo is still enchanted, and as a subject in the study of mysticism the man of science must yet regard it. The lore of a millennium is not undone by a few hours of iconoclasm.

ELECTRIC STREET RAILWAYS

According to the *Western Electrician*, there were, on January 1, 1897, 15,250 miles of street-car track in the United States, of which 13,580 miles, or 89 per cent, were operated by electricity, 1,010 miles, or 6.6 per cent, by horses, 515 miles, or 3.4 per cent, by cable, and 145 miles, or 1 per cent, by steam dummy. The adoption of electricity as a motive power has completely revolutionized the methods of city and suburban transportation. Between January 1, 1888, and January 1, 1897, the number of horse cars in use decreased from 21,736 to 3,664, while the number of electric cars increased from 172 to 37,097. In 1888 horse cars represented 86 per cent and electric cars seven-tenths of one per cent of the total car equipment. At the beginning of the present year 79 street cars out of every 100 were propelled by electricity and only seven out of 100 by horses. J. H.

MODIFICATION OF THE GREAT LAKES BY EARTH MOVEMENT—AN ERRATUM

We regret to state that two of the figures illustrating Mr Gilbert's article in the September number are transposed. The narrow figure on page 240 belongs on page 241, and the square figure at the top of page 241 belongs on page 240. As the figures stand, they are associated with the wrong titles.

GEOGRAPHICAL RESEARCH IN THE UNITED STATES*

By GARDINER G. HUBBARD, LL. D.,

President of the National Geographic Society,

AND

MARCUS BAKER,

U. S. Geological Survey

The United States, now a little more than a century old, comprises an area of 3,600,000 square miles, an area a little greater than that of Canada and a little less than that of Europe. From easternmost Maine to westernmost Alaska it stretches through 120 degrees of longitude, or about one-third of the earth's circumference. Thus, in midsummer, sunrise in eastern Maine occurs 20 minutes before sunset in westernmost Alaska. From southernmost Florida, reaching to the verge of the torrid zone, it stretches northward to northernmost Alaska, more than 300 miles within the Arctic circle, while in altitude it ranges from 200 or more feet below sea level in the deserts of southern California to heights of more than 18,000 feet in Alaska.

Beginning with the close of the war for independence, 114 years ago, as 13 distinct and independent states stretching along the Atlantic seaboard from New Hampshire to Georgia, we have first a loose confederation of states which, speedily breaking down, was replaced by the present constitutional union of the people, bound together in 45 sovereign states and 5 territories. In 1790 the 13 states had an area of about 350,000 square miles and a population of a little less than 4,000,000. A century later its area was nearly eleven times as great and its population about seventeen times as great, or between 65 and 70 millions.

Discovery of what is now the United States began just four centuries ago this very year, when the Bristol merchant Cabot, the first white man (after the Norsemen) to set foot on the American continent, antedating Columbus by fourteen months, landed on the bleak coast of Labrador, and then cruised southward as far as Virginia. This, like all discoveries, was only a beginning,

*An address before the Geographical Section of the British Association for the Advancement of Science, at Toronto, August 23, 1897.

which pointed the way to and stimulated other discoveries. These are still unfinished, and within the limits of the United States some tracts still exist which have never been seen by the white man. Of other tracts, though seen and long vaguely known, our knowledge is still dim and shadowy.

For a century after Cabot small advance was made in our knowledge of the continent formally taken possession of by him in the name of his sovereign lord, King Henry VII. The outline of the Atlantic and Gulf coasts were crudely delineated, but of the Pacific coast north of California our maps until about 1750 were either blank or filled with fabled lands or monsters. Bering's voyage of 1741 yielded the first definite knowledge of northwestern America, but it was not until nearly 40 years later, in 1778, that Cook, the great English navigator, gave to the world the general outlines of Alaska as we now know them. The general features of the coast of western North America obtained by Cook were some 16 years later vastly improved, from southern California to Kadiak, by another English navigator, the equal if not the superior of Cook, whom every American student delights to honor, Capt. George Vancouver.

The period of the war for independence in the last quarter of the last century was one of great geographic activity and stimulated the production of maps of the revolted colonies. The numerous and excellent, for their time, maps by the English geographer, Jefferys, may be taken as the best exponent of American geography one hundred years ago. They show fairly well the Atlantic coast line from the maritime provinces of Canada to Georgia, and so much of the interior as was the scene of hostilities; but west of the Appalachian mountain chain the delineation was conjectural. The existence of the Great Lakes, of the mighty Mississippi, and of the fertile valley drained by it were barely known.

Such was the world's geographic knowledge of what is now the United States when those states united in 1789. The knowledge subsequently acquired is the work of the United States, the individual states, private persons, and corporations.

The General Land Office.—One of the earliest agencies by which geographic knowledge was increased was the General Land Office.

The general government found itself in 1783 possessed of a region called the Northwest Territory, lying beyond the mountains. Into this region settlers came about the beginning of the century. That they might acquire title to land for their homes, the gov-

ernment early devised a system of land partition. Surveyors were sent into the wilderness to subdivide the land for purposes of record and sale or gift. The land was divided into square tracts six miles on each side, called towns or townships, and their corners marked, sometimes by ax marks on trees called *blazes*, and sometimes by artificial marks. A row of such towns running north and south is called a *range*, and numbered E. and W. from some arbitrary meridian. Similarly a row of towns running east and west is called *town*, and is numbered north or south from an arbitrary base line. Each town was further subdivided into 36 squares, each containing one square mile, or 640 acres, called a section. The sections are similarly numbered from 1 to 36 in every town. Each corner of each section was marked by the surveyors, who were thus required actually to chain over every mile, to keep a record of their measures, to note all streams and lakes, and the character of soil and timber; to note the magnetic declination, and to submit to the General Land Office a skeleton map of each town subdivided, together with their field-notes. These maps, called town plats, now constitute a vast body of original records in the General Land Office in Washington, and are the sole dependence of map-makers for hundreds of thousands of square miles of our territory. Every state and territory in the Union except the original thirteen, Maine, Vermont, Kentucky, Tennessee, Texas, and Alaska, has been thus in whole or in part surveyed and subdivided. This work, now far advanced toward completion, has always been under the control of the General Land Office, now a part of the Department of the Interior.

For geographic purposes the results are shown in a series of state maps and a general map of the United States. The work was for about a century done by contract, but within the past two or three years a part has been done by the U. S. Geological Survey in connection with its topographic surveys.

Thus indirectly the General Land Office has for a century been and still continues to be one of the important geographic agencies of the United States.

Coast and Geodetic Survey.—Another old and important geographic agency is the Coast and Geodetic Survey, under the Treasury Department. The primary purpose of this bureau was to accurately chart the coast for purposes of commerce and defense. Its field of work is tidewater with a fringe of topography landwards and a somewhat extensive border of sea bottom seawards. Created in 1807, it made little progress till 1832. In that year it

was revived and has continued uninterruptedly till the present day.

From the beginning its ideals were high. Great accuracy has ever been and is its motto. It has been a leader and not a follower. It has developed its own methods and instruments, and to its officers, civil, military, and naval, we are indebted, among other things, for the zenith telescope for the most accurate determination of latitudes; for the application of the telegraph to longitude determinations; for the invention, construction, and use of a machine for predicting tides, and for great improvements in apparatus for measuring the force of gravity. The polyconic projection now so extensively used was developed and applied by officers of this bureau, as also were appliances for deep-sea sounding and the study of the ocean deeps.

Its field of work was extended in 1871 to include geodetic work in the interior, and in 1876 it received the name of Coast and Geodetic Survey, by which it is officially designated, though often referred to as the Coast Survey. It is one of the active geographic agencies of the United States, and is not only making charts, coast pilots, and tide tables, but is contributing to our knowledge of ocean physics, terrestrial magnetism, and of the size, shape, and structure of our planet.

Engineer Corps, U. S. A.—The U. S. Engineers, though not now actively prosecuting geographic research, have in the past made notable contributions to geography. Prior to and even since the war of the rebellion, 1861–'65, numerous expeditions in the far west were made by army officers, and each of these added something to our geographic knowledge. Aside from these various military reconnaissances two noteworthy surveys have been carried on in the past by the U. S. Engineers. One was a survey of the northern and northwestern lakes, which, after an existence of forty years, was concluded in 1881. It made a series of detailed and accurate charts of all the Great Lakes, and a valuable collection of data. Its series of lake levels has very recently been put to use in determining certain secular changes in the crust of the earth forming the great basin in which those lakes lie. If the slow tilting of this basin southward which these levels show, when compared with recent ones, continues for a period of about 6,000 years, then it is calculated that Niagara will have vanished, and all the lakes except Ontario will drain to the Mississippi by way of the Chicago outlet. These highly interesting and somewhat startling conclusions have just been presented at

the Detroit meeting of the American Association for the Advancement of Science by Mr G. K. Gilbert, of the U. S. Geological Survey.

Another noteworthy geographic work by the U. S. Engineers was a general map-making survey in the far west under the direction of Capt. George M. Wheeler, U. S. E., and usually referred to as the Wheeler survey. A considerable tract of country was mapped by it on a scale of 8 miles to 1 inch. This survey with two others, the so-called Hayden and Powell surveys, were merged in the present Geological Survey in 1879.

The work of improving rivers and harbors in the interest of commerce is now carried on by the United States engineers, and their geographic work consists in special surveys for these improvements and of a new survey of the Great Lakes.

Geological Survey.—The chief agency for increasing geographic knowledge of the United States at the present time is the United States Geological Survey, now eighteen years old. Nearly or quite one-half of its energies and funds are expended in the production of topographic maps, and thus it is in fact, though not in name, the United States Topographic and Geologic Survey. The conditions confronting this survey at its creation differed in one important particular from those similarly confronting European geological surveys. Those surveys had, in almost if not quite every case, been preceded by topographic surveys, and the geologists found maps, adequate to their needs, ready made. But in the United States topographic maps were not available, as there had been no topographic survey. Thus progress in geologic mapping was impeded at the outset by the lack of suitable maps. Accordingly in 1882 authority was given to make topographic maps, and since then about one-half of the energies of the Survey have been given to their production. Since 1882 the Survey has surveyed and mapped on scales of one, two, and four miles to the inch an area of 760,000 square miles, almost equal to the combined areas of Great Britain, France, Germany, Spain, and Portugal. The results are contained on 980 atlas sheets, 460 on the one-mile scale, 460 on the two-mile scale, and 60 on the four-mile scale. These surveys have been made in nearly every state and territory. Following these came the geological surveys. But before much progress was possible a large amount of preliminary investigation was needful to determine the great features whose details were to be wrought out and mapped. A system of rock classification uniformly applicable to so great and

complex an area as the United States required much careful preliminary work. That has been accomplished and systematic geologic mapping has been in progress for some years.

The aspect of the country and its utility for man's use is largely dependent on the annual rainfall. This ranges from a very few inches in the driest part of the arid or desert regions of the southwest to nearly or quite 8 feet per year on the coast of Southern Alaska. As the humid regions were settled up population gradually pushed into the semi-arid and desert regions of the far west, where agriculture without artificial irrigation is impossible, but *with* irrigation marvelously successful. Thus came a demand for knowledge as to water supply, and to this work one division of the Geological Survey is wholly devoted.

Intimately associated with water supply is the forestry problem. The proper administration of the forests—their preservation from destruction by carelessness or greed—is a question now attracting serious attention. A number of large forest tracts in the west have been recently set apart as reservations, and these, with the Yellowstone National Park, the Yosemite, and others previously reserved, comprise a total area estimated at 38,880,000 acres, or more than 60,000 square miles. In the budget for this year Congress has included an item of $150,000 for the survey of these forest reserves. This work is under the direction of the United States Geological Survey.

The output of the mines and quarries of the United States has grown in value from $369,000,000 in 1880 to $622,000,000 in 1896. That authentic information on this subject might be promptly available a division of mineral statistics has existed in the Geological Survey from the beginning, charged with the duty of gathering and publishing statistics. This it does in an annual volume devoted to mineral statistics, and the state of the mining industry from year to year finds permanent record in these volumes.

Navy Department.—The Hydrographic Office of the Bureau of Navigation has for a primary aim the securing and publication of information useful to those who go down to the sea in ships. This includes surveys and chart-making of all coasts (except those of the United States), ocean meteorology, terrestial magnetism, and ocean physics. The charting of the coasts of the United States is done exclusively by the Coast Survey, which has nearly completed the Atlantic and Gulf coasts and about three-fifths of the Pacific coast, except Alaska, of which only a small

part is as yet surveyed. Of foreign coasts, the Hydrographic Office has recently surveyed and charted the western coast of the peninsula of Lower California, one of the Mexican states, about 1,000 miles in extent. It has extended our knowledge of the sea abysses by various lines of soundings in the interest of projected cable lines, and it lessens the perils of ocean travel by the monthly issue of pilot charts of the North Pacific and North Atlantic oceans, containing data as to derelicts, ice-fields, storm tracks, and other information useful to the mariner. The systematic collection of data for these pilot charts results in a constant increase in our knowledge of the geography of the sea.

Weather Bureau.—To investigate the history, structure, and contents of the crust of the earth is the peculiar province of the Geological Survey; to study the currents, movements, and characteristics of the earth's salt-water envelope is the province of the Coast Survey and the Hydrographic Office; to investigate the character, amount, habits, and migrations of its contained life is the province of the Fish Commission. The study of the all-enveloping gaseous ocean in which we live and move—that invisible sea of air with its ever-varying moods of restful calm and fierce storm, now delightfully transparent and now somber or menacing with storm-cloud, sometimes scorching and sometimes freezing—the study of this gaseous envelope, of the laws which govern its behavior and the daily deduction from these laws which foretell to the sailor, the farmer, the traveler what he may expect—is the peculiar province of the Weather Bureau. May we not properly call this field of study the geography of the air? And has it not ever formed a large chapter in our physical geographies? The weather service in the United States is 27 years old, dating from 1870. At first it was a military organization called the Signal Service, and its purpose was to give "notice on the northern lakes and on the seacoast, by magnetic telegraph and marine signals, of the approach and force of storms." Its primary object was, therefore, not the study of climate, but the prediction of storms. It seeks to tell the weather of tomorrow rather than that of the last year or the last century. But, as we are forced to judge the future by the past, the study of meteorological records is not neglected, and within the bureau there has ever been a corps of scientific experts at work upon such lines as gave promise of producing something new or useful for the forecaster. The bureau is now a civilian one, having been transferred from the War Department to the Department of Agriculture. Its present

field of activity is far wider than we have indicated—so wide, indeed, that time will not permit even a mention of details.

Thus have we briefly summarized and characterized the work carried on by the greater geographic agencies of the government of the United States; and yet such summary would be incomplete without mention at least of several other agencies still at work and actively contributing to a fuller and better knowledge of our geography.

The total railroad mileage of the United States, not counting second or third tracks or sidings, is in round numbers 180,000 miles, or about 45 per cent of the world's mileage. To locate and construct these thousands of miles of road, much of it running through districts little or quite unknown when preliminary surveys began, has involved a vast expenditure of money by which geographic knowledge has been increased. It has been estimated, perhaps it would be more exact to say guessed, that the sums expended on these railroad surveys is enough to have produced a topographic map of the entire country. The chief geographic contribution from these surveys is a knowledge of altitudes. Over all these railroads lines of level have been run, and by collecting and platting those levels and adding to them those obtained from other sources, it has been possible for the Geological Survey to produce a fairly approximate contour map of the United States.

The Mississippi river, with its tributaries in the great central valley of the United States, drains an area of about 1,200,000 square miles, or about one-third of the United States. From the sources of the Missouri to the passes at the mouth of the Mississippi in the Gulf of Mexico is 4,200 miles. These two great rivers, with their affluents, afford thousands of miles of navigable water through the great central valley. So important is this artery of commerce that two distinct commissions, one for the Mississippi and one for the Missouri, have existed for some years for the purpose of surveying, mapping, studying, and improving them. Detailed maps of the rivers and a fringe of topography on either side have been made over a considerable part of the navigable parts of these rivers, and the results are shown on 240 atlas sheets. Much precise leveling has also been carried on in connection with these surveys.

Independent of the Federal government, various states, to the number of 20 or more, particularly those known to possess min-

eral wealth, have conducted geological surveys, or perhaps it should be said geological reconnaissances. Two have conducted topographic surveys and four have coöperated with the general government in making topographic surveys. These four, Massachusetts, Rhode Island, Connecticut, and New Jersey, as also the District of Columbia, are now completely mapped on a scale of one mile to the inch and in contours with a vertical interval of 20 feet.

The Post Office Department, for its own purposes in administering the 70,000 post-offices under its control, compiles state maps showing post-routes and political divisions. The boundary lines shown on these maps are compiled from the laws and by correspondence, and constitute an authentic source of information as to minor boundaries.

Allusion has been made to the work of the Fish Commission in studying the character, habits, and migrations of marine life, and by its side should be mentioned the similar work on land carried on by the Biological Survey in the Department of Agriculture.

Of the great advances in geographic knowledge resulting from the explorations of Lewis and Clarke near the beginning of the century; from the work of Fremont, the Pathfinder; from the Pacific Railroad surveys of 50 years ago, and from numerous military expeditions, time fails for more than a bare mention.

These, then, are the greater geographic agencies of the United States. Some of them will be presented to you more at large by the gentlemen actually conducting the works outlined.

As to the future, it will easily appear that the amount already achieved is but a small part of what remains to be done. Geographic research and progress in the United States has never been swifter or more active than it is today, and knowledge of environment and resources is gathered in large installments each year. To discover and develop its resources the United States is now employing about 5,000 persons and expending nearly $8,000,000 annually. Just as the Royal Geographical Society of London began sixty-seven years ago its work of fostering and promoting geographic research, so the National Geographic Society of Washington nine years ago entered upon similar work. Great and lasting good has resulted from each undertaking. May their efforts continue till dark continents and unexplored regions shall have vanished from our maps.

A BRIEF ACCOUNT OF THE GEOGRAPHIC WORK OF THE U. S. COAST AND GEODETIC SURVEY*

By T. C. MENDENHALL, LL. D., Ph. D., etc.,

President of the Worcester Polytechnic Institute, and formerly Superintendent of the Coast and Geodetic Survey, Washington, D. C.,

AND

OTTO H. TITTMANN,

Assistant in Charge of the Office of the Survey

While a relatively small part of the energies of the United States Coast and Geodetic Survey has been devoted, since the creation of the Bureau in 1807, to geographic exploration, it is, perhaps, only just to say that in the character and amount of its precision work it is second to no similar organization in the world. From the very start the standard of work has been the highest attainable in the existing condition of the arts and sciences on which such work must depend, and often, not content with that condition, the Survey has made it its business to better it by original investigations of the first class, leading to improvements in the instruments and methods of the highest importance. It thus became the principal and for many years almost the only bureau of the Government in which exact science was cultivated. In its outward activities it was essentially an organization for the practical application of science to the solution of certain problems and the issue of certain publications which were of the utmost value to commerce.

The duties to be performed by it were to sound the depths of the ocean along the coasts of the United States, to define the shallows which barred the ways of commerce, to delineate with great accuracy the shores and physical condition of the thousand harbors and estuaries with which a benign Providence has blessed our coasts, to investigate the tides and currents of the waters which bear their precious burden of human lives and property to and fro, and to study the mysterious variations and uncertainties of the magnetic needle by which the course of the navigator was largely directed.

*Read before the Geographical Section of the British Association for the Advancement of Science, Toronto, August 23, 1897.

To these immediate problems the Survey addressed itself with vigor and foresight under the guiding hands of Hassler and his eminent successors. Hassler, the friend of Jefferson and Gallatin, enjoyed the confidence and support of these eminent statesmen, but he had before him difficulties as great as his field was wide. Inert public opinion as to the utility of the proposed Survey had to be vitalized and molded, men had to be trained to carry out the technical parts of the work, instruments had to be constructed, and correct methods had to be prescribed. How these difficulties presented themselves and how they were overcome will form a proper chapter not only in the history of the great Survey which yet remains to be written, but also in the history of the progress of science in this country.

It may be said that Hassler, in 1844, saw the fruition of his hopes when a general plan of operations prescribed by him was adopted by a scientific commission composed of Army and Navy officers and civilians. Its adoption marks the official recognition of the necessity for precise and systematic work in the mapping of our domain. Its simple and correct outline of the operations to be followed in making a survey of great extent has permitted the extension of the work in a manner commensurate with the enlargement of our national domain by acquisitions of territory from France, Spain, and Mexico. With the expansion of territory came the extension of the scope of the survey, and finally, when the advantages of a transcontinental triangulation became apparent, its geodetic function was recognized by law.

In accordance with its primary duties the Survey has developed and charted the depth of the waters along our coasts with extreme minuteness and accuracy, not only in the rivers, bays, and harbors, but off shore as far as the needs of commerce demanded it. Going beyond the immediate requirements of the mariner, it has devoted itself to discovering the depths of the sea over large areas, as is shown by the complete survey of the Gulf of Mexico. Its depths were sounded and charted, its salinity tested, and the temperatures of its waters were recorded. Much earlier than these successful surveys of the Gulf were the explorations of the Gulf Stream, important not alone in their geographic results, but in developing methods, often by failures, which rendered subsequent success possible. The hydrographic results achieved are shown on between five hundred and six hundred charts, many of them of such exquisite perfection as to form a standard of excellence for all cartographers.

Its researches in physical hydrography include not only the study of the tides and currents and incidentally the establishment of planes of reference from which the constancy of the relation between the ocean level and the land is to be inferred, but it has studied for future comparison the movements of sandy shores, as, for instance. those of Cape Cod and of the exposed islands of Nantucket and Marthas Vineyard, to discover the relationship between the outlying shoals and the changes of the shores. Here, again, precision of work alone is of any avail, for correct conclusions can be drawn only after the lapse of time and after a standard of comparison has been created by an accurate survey. Want of space forbids the enumeration of many special results, but the discovery of the value of the tidal circulation through the East river as a factor in maintaining the depth of the bar at Sandy Hook and the discovery of the underrun of the Hudson and its bearing on the feasibility of obtaining a water supply for the towns along that river may be mentioned as contributions in a special field of geography.

As properly belonging to the subject of the hydrographic surveys, the literature of the several and successive volumes of the Coast Pilots, published by the Survey, must be mentioned. The Coast Pilots of Alaska, compiled by Davidson and later by Dall, are invaluable historical records of the geography of that coast, and the same may be said of the volumes covering the remainder of the Pacific coast and those which describe in detail our Atlantic shores. They are not intended to deal in generalities, but they describe with rigid particularity geographic landmarks which are to guide ships by day and by night.

The maps of the Survey are embellished by accurate representation of the topography which borders our shores. For thousands of miles a narrow fringe of topography has been mapped with minute and necessary accuracy. It is based on local and detailed triangulation, which in turn rests on a larger network of triangles which coördinates all the surveys along the coasts.

The introduction of precise methods for the determination of latitudes and longitudes went hand in hand with all the other operations of the Survey. Thus the success of Morse in the spring of 1844 was followed in the autumn of the following year by formal instructions given by Bache to Walker to prepare for telegraphic longitude determinations; but it was not until October 10, 1846, that the method was successfully put into practice by the exchange of signals between Philadelphia and Wash-

ington, and thereafter the precise determination of longitudes had merely to await the extension of the telegraph system from point to point within our own borders and throughout the world. As soon as the Atlantic cable had been laid in 1866, the Survey successfully undertook to determine our longitude from Greenwich by the telegraphic method. Up to that time the longitude adopted for Cambridge, Massachusetts, in 1851, was used. The adopted value (4 h. 44 m. 39.5 s.) had been derived from many years of laborious observations of moon culminations, eclipses, occultations, and chronometer determinations, but this value was increased (in 1869) by 1.35 s., as the result of comparatively brief cable determinations. Similarly, the longitude adopted for San Francisco in 1855, as the result of 206 moon culminations, was increased in 1869 by 3.1 s., in linear measure about ¾ of a mile, by the telegraphic determination.

Within the past year the Survey has completed and adjusted its primary longitude net covering the whole United States and fixing for all time the astronomical longitudes of the points included in it, not only in their relation to each other, but, in all probability, their final relation to the initial meridian of Greenwich, since in this adjustment three transatlantic determinations by the Coast Survey and one by the Canadians have been used. Less need be said of the many latitude determinations, since the methods adopted, though admirable in their precision, involved no such radical improvement as that which the telegraph brought about in the determination of longitudes. On the other hand, however, the zenith telescope, as developed by the Survey, has in the hands of its observers contributed materially to our knowledge of the variation of latitude.

Reference has been made to the geodetic function of the Survey. It has measured an oblique arc, the last triangles in which have but just now been observed, extending from the northeastern boundary to the Gulf of Mexico. To join this with the primary chain, as yet incomplete, of triangles along the Pacific coast, a great arc has been measured along the 39th parallel of latitude, the completion of which has been but recently announced.

The adjustment of the triangulation along this great arc and the adoption of a homogeneous system of geographic coördinates will furnish the fundamental data for the coördination of all Government or State surveys for all time to come, if it be permitted to fallible human wisdom to make such an assertion.

Grand in its inception, splendid in its execution, this monumental work may be reckoned as the most important contribution to the geography of our country, on account of its present and prospective value. The measurement of a great meridional arc along the 98th meridian is in contemplation, and our sister Republic of Mexico, which has just established a Geodetic Survey, it is hoped will take a hand in its extension southward, while to our cousins across the northern border a similar opportunity for its prolongation northward may be offered in the course of time.

The Survey has been especially called upon for assistance in defining the boundaries of eleven States, and aid has been extended to fifteen others by the determination of geographical positions within their borders. In the determination of the national boundaries it has coöperated in retracing the line between Mexico and the United States, has made topographic surveys along the northeastern boundary, and in the far north it has determined the crossing of the 141st meridian on the Porcupine and Yukon rivers in regions to which all adventurous eyes are now turned, and in southeast Alaska it has made exploratory surveys, as well as precise geographic determinations, for the ultimate delineation of the boundary between Alaska and the British possessions.

The enormous extent of the country included in the operations of the Survey, and especially its nearness to the principal north magnetic pole, offered a rare opportunity for the investigation of the problem of terrestrial magnetism. Observations began at an early date, and have been continued up to the present time at a constantly increasing number of stations. In addition to a regular, periodic study of the magnetic elements at a large number of specially selected points by the most approved methods and the best of instrumental appliances, the Survey has maintained a photographic registering magnetic observatory, which it has moved from time to time from one part of the country to another. It has made extensive publication of the data thus obtained, including a series of magnetic charts which are of the greatest value to navigators at sea and surveyors on the land. Its archives contain a mass of reliable information concerning terrestrial magnetism unequaled in extent and importance.

In common with several similar organizations in Europe, it has devoted much attention, mostly during the past twenty-five years, to the study of terrestrial gravity. Beginning with methods

long in use, its observers were quick to detect and point out certain serious and hitherto unsuspected faults, necessitating considerable corrections in nearly all accumulated data relating to that subject. Instruments were also improved and methods greatly changed, increasing at once the precision and rapidity of gravity measurements. Expeditions have been sent to various quarters of the globe for the purpose of gravity observations, and Coast Survey pendulums have swung in all continents except Australia, in most important cities, on several of the highest mountains, and on many islands in the several oceans. No others have been vibrated so near the pole as these and none over so wide a range in longitude. The results of these operations, together with the measurement of the great arc of unrivaled length, form a contribution of no ordinary interest to the more precise solution of the great problems of dimensional geography.

UNITED STATES DAILY ATMOSPHERIC SURVEY*

By Prof. WILLIS L. MOORE,

Chief of the U. S. Weather Bureau

The United States Weather Service has been in existence twenty-seven years. During the past twenty-five years the daily synoptic charts of the service have shown the most comprehensive atmospheric survey ever presented to the forecaster or to the broad investigator of the fundamental principles of storms. The vast region now brought under the dominion of bi-daily synchronous observations embraces an area extending 2,000 miles north and south, 3,000 miles east and west, and so fortunately located in the interest of the meteorologist as to cut an important arc from the circumpolar thoroughfare of storms of the northern hemisphere. The extreme points of observation are Edmonton, in the Canadian Province of Alberta, on the northwest; St Johns, on the northeast; Key West, on the southeast, and San Diego, on the southwest; and arrangements are now complete for a coöperation with Mexico similar to that in operation with Canada, which will in a few months extend the area of observation southward over Mexico and Yucatan.

It is a wonderful panoramic picture of atmospheric condi-

*Read before the Geographical Section of the British Association for the Advancement of Science, Toronto, August 23, 1897.

tions, which by the aid of simultaneous measurements and the electro-magnetic telegraph joining the places of observation by a magic touch is presented to the trained eye of the forecaster. Each twelve hours the kaleidoscope changes and a new graphic picture of actual conditions is shown. Where else can the meteorologist find such opportunity to study storms and atmospheric changes?

In the middle of the eighteenth century Franklin detected the rotary and progressive motions of storms; early in the nineteenth century Redfield and Espy contended over rival theories as to the mechanical principle involved in the formation of storms, and a little later Maury studied the storms of the Atlantic ocean; still later Loomis, Dove, and Ferrell reviewed these theories and added much to our knowledge; but at this late date no one has been able to satisfactorily coördinate the forces operative in cyclones or to assign quantitative values to the horizontal temperature and pressure gradients, to the surface and internal frictions of convection, to centrifugence, to the latent heat of condensation, and to the effect of hemispherical circulation. Probably the only component of cyclonic force that is well understood and accurately computed is the deflection due to the earth's rotation.

Our early investigators studied only the storms of low levels and humid airs, where convection was only needed to carry the moist air currents to but a slightly higher elevation before cooling by expansion would produce condensation and an immediate acceleration of the cyclone by the liberation of latent heat. They had never seen the whirling cyclones of the arid northern Rocky Mountain plateau dash down upon our Great Lakes with rapidly increasing energy, notwithstanding the fact that there was little or no condensation, and hence no addition of the latent heat which Espy supposed was absolutely essential to a continuation of storms.

The widely differing elevation, topography, temperature, and aridity of the broad region under observation give conditions which are unequaled anywhere in the world for the advantages which they present to the physicist to study the mechanical phases of storm development and progression, or at least such as can be profitably studied with observations taken only at the bottom of the great aerial ocean surrounding the earth.

Here we see summer cyclones formed under the intense insolation which beats down through a diathermanous atmosphere upon the arid waste of the Rocky Mountain plateau; cyclones

which, if they form in the northern part of the plateau region, move eastward to our lakes and thence to the St Lawrence with scant rainfall; cyclones which, if they have their origin farther south on the warmer plains of Colorado, move into the Ohio valley and thence into New England with considerably more precipitation; and cyclones which, if they have their inception on the hot and high plains of Arizona and New Mexico, can always be expected to give abundant rainfall when they reach the lower Mississippi valley, and later as they pass over the Middle Atlantic states. All these can be studied during their inception at an average altitude of 5,000 feet above sea level and under conditions of extreme aridity; they can be viewed later as they come down nearly to sea level in the Mississippi valley and reach a more humid atmosphere 1,000 miles from the place of their birth; and, finally, they are seen as they reach the extremely humid air of the Atlantic ocean, 1,500 miles farther east.

The great winter cyclones which originate south of the Japanese islands and cross the Pacific ocean come under our vision as they successfully surmount the formidable Rocky Mountain barriers with but little diminution of energy, sweep across our continent with increasing force and heavy precipitation, and within three days pass beyond our meteorological horizon at the Atlantic seaboard only to be heard from three days later as borean ravagers of northern Europe.

The great anti-cyclones or high-pressure eddies, which constitute the American cold waves, drift into our territory from the Canadian Northwest provinces and are studied under rapidly changing conditions during 3,000 miles of their course. The high-pressure eddy, with all the convectional principles of the cyclone reversed, may be said not to depend upon the land of its birth for the cold it brings, for a strong vortical and anti-cyclonic motion at the center is continually drawing down the cold air from above. In the cold wave it must be conceded that the loss of heat by radiation to a cloudless sky is much greater than that gained by compression, or else it must be assumed that the atmosphere possesses such intense cold at the elevation from which the air is drawn that, notwithstanding the heat gained by compression in its descent, it is still far below the normal temperature at the surface of the earth.

The West Indian hurricanes, always at sea level and in humid air, which are the most violent of all American storms, intrude themselves into the domain of the United States weather map at

the bend of their parabolic course, at about latitude thirty. They have for years furnished a fruitful theme for the thoughts of the investigator.

For twenty-seven years the forecasters of the Weather Bureau have studied the inception, development, and progression of these different classes of atmospheric disturbances. From a knowledge personally gained by many years service as an official forecaster, I do not hesitate to express the opinion that we long since reached the highest degree of accuracy in the making of forecasts possible to be attained with surface readings. It is patent that we are extremely ignorant of the mechanics of the storm, of the operations of those vast yet subtle forces in free air which give inception to the disturbance and which supply the energy necessary to continue the same.

Having long realized this, I determined at once, on coming to the control of the United States Weather Bureau, to systematically attack the problem of upper-air exploration, with the hope ultimately of being able to construct a daily synoptic weather chart from simultaneous readings taken in free air at an altitude of not less than one mile above the earth, as it appeared to me that previous plans for investigating the upper air by means of free and uncontrollable balloons, by observers in balloons, or by independent kite stations were of little value in getting the information absolutely necessary to improve our methods of forecasting. Simultaneous observations at a uniformly high level from many kite stations was the plan I inaugurated for the prosecution of this important investigation. Professor Marvin was assigned to the difficult task of devising appliances and making instruments, and I am pleased to say that we have improved on kite-flying to such an extent that apparatus is now easily sent up to a height of one mile in only a moderate wind. We have made an automatic instrument that, while weighing less than two pounds, will record temperature, pressure, humidity, and wind velocity. Before next spring we expect to have not less than twenty stations placed between the Rocky mountains and the Atlantic ocean taking daily readings at an elevation of one mile or more.

We shall then construct a chart from the high-level readings obtained at these twenty stations and study the same in connection with the surface chart made at the same moment. Being thus able to map out not only the vertical gradients of temperature, humidity, pressure, and wind velocity, but the horizontal

distribution of these forces on two levels, it is hoped to better understand the development of storms and cold waves and eventually improve the forecasts of their future course, extent, and rate of movement.

In exceptional cases we have flown the kites to a height of nearly two miles. From daily readings at only one kite station, at Washington, we have derived information as to the direction and force of the wind above the one-mile level, which has greatly assisted us in estimating the future direction of a storm center when our surface chart gave but negative indications. It will be a fascinating study to note the progress of cold waves at this high level and to determine if the changes in temperature do not first begin above. The readings at Washington indicate that contending equatorial and polar winds may be more potent in the formation of storm eddies than heated and ascending convectional currents.

I am anxious to know the difference in temperature between the surface and the upper stratum in the four quadrants of the cyclone and in the four quadrants of the anti-cyclone, especially when the storm and cold-wave conditions are intense. At an elevation of five miles but little effect remains of diurnal temperature variation. At this altitude the atmosphere is free from the disturbing influence of immediate surface radiation, and consequently there is but little change between the temperature of midday and midnight. The vertical distribution of temperature in the several quadrants of the cold-wave or rainstorm areas may give a clue to the future direction of the storm. When we are able to construct isobaric gradients at the one-mile level it may be discovered that the storm center at that elevation will not always coincide with the geographical location of the storm center at the surface of the earth. The displacement of this center may possibly give some indication of the future direction of the storm. There are many interesting problems to be solved by this investigation.

The Eleventh International Congress of Orientalists was opened at Paris on September 5, with 800 members in attendance. One of the most interesting discussions had reference to the proposed dictionary of hieroglyphics, which is to be compiled under the auspices of the German government by members of the academies of Berlin, Göttingen, Leipzig, and Munich. It is expected that the actual publication will begin in 1908 and be completed by the end of 1913.

GEOGRAPHIC NOTES

AFRICA

SIERRA LEONE. The first section of the first railroad in British West Africa is now being operated between Freetown and Wellington.

BRITISH SOUTH AFRICA. A company has been formed to construct and operate a line of railway from Umtali to Salisbury, a distance of about 160 miles. Umtali is the terminus of the existing Beira railway system.

ABYSSINIA. A recent report on the trade of Adis Abbata states that ivory, which could once be obtained at the rate of a tusk for a percussion musket, is now sold at from $80 to $100 for 40 pounds. Coffee of good quality grows wild in many parts of the country.

CENTRAL AMERICA

BRITISH HONDURAS. The report of the government surveyors on the practicability of the proposed railroad from Belize to the western frontier of the colony (a distance of 72 miles) estimates the cost of construction at $3,575,237, or nearly $50,000 per mile. It is considered doubtful if the road would pay interest on so large an investment unless it were continued into Guatemala, and negotiations looking to that end are now in progress.

NICARAGUA. Mr Thomas O'Hara, U. S. consul at San Juan del Norte, states in a recent report that there is neither a cellar nor a chimney in that city. All the buildings are of wood, although lumber is expensive and short-lived, the climate and wood ants combining to play havoc with it. The exclusive use of wood (except in a very few cases for foundation purposes) is not due to fear of earthquakes, but to the fact that there is neither stone nor brick-clay in the vicinity. There is, however, no market for imported brick.

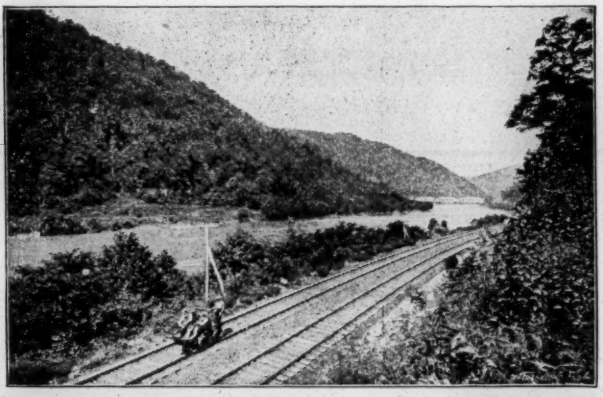
SOUTH AMERICA

VENEZUELA. The government of Venezuela has ceded to Messrs Rutgers de Beaufort, bankers, of Amsterdam, the monopoly of all the salt mines in the country, in consideration of the establishment of a new bank in Caracas with a capital of $3,860,000. The bank will have the right to establish branches and to issue notes to double the amount of its capital. The concession is reported to have created great dissatisfaction among the people.

BRITISH GUIANA. A recent writer on the gold industry of British Guiana says that whether the colony has a future as a gold-producing country is a question not yet removed from the region of doubt. There is no denying the fact that the central areas are richly auriferous, but the difficulties and dangers attending the navigation of the rivers constitute an enormous obstacle to the working of the deposits. The total gold production of the colony for the year ending June 30, 1897, was 128,334 ounces, as against 119,422 ounces in 1895-'96, and 138,279 ounces in 1892-'93.

J. H.

C&O ROUTE



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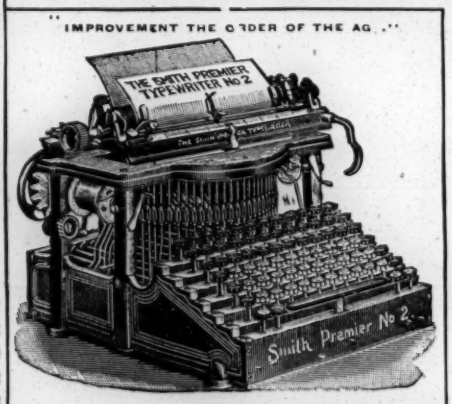

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N ..... E .....

S ..... W .....

HAND	COMPASS WHIST SCORE	COMPASS WHIST TOTALS	COMPASS WHIST TRUMP	COMPASS WHIST OPPONENTS	HAND
	DUPLICATE WHIST SCORE	DUPLICATE WHIST GAIN	DUPLICATE WHIST TRUMP	DUPLICATE WHIST GAIN / SCORE	
1					1
2					2
3					3
4					4
5					5
6					6
7					7
8					8
9					9
10					10
11					11
12					12
13					13
14					14
15					15
16					16
17					17
18					18
19					19
20					20
21					21
22					22
23					23
24					24
TOTALS					TOTALS

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